INFLUENCE OF JOSHI EFFECT ON THE EMISSION SPECTRUM OF CHLORINE

By P. G. Deo

(*Received for publication, April 27, 1951*)

Plates XIX A & B

ABSTRACT. When irradiated by 4750-4000 Å the relative Joshi effect, $\%\Delta i$, $(100\Delta i/i_{dark})$ in 100 mm chlorine was a maximum *viz* 86, at the threshold potential 6.9 KV: the corresponding glow intensity was extremely low. Increase of potential increased the intensity but diminished $\%\Delta i$. With 120 hours exposure, the spectrum was recorded (*i*) with the tube excited at 11 3 KV; (*ii*) with the tube excited and also irradiated by 4750-4000 Å, the $\%\Delta i$ being 70 and (*iii*) with the tube unexcited but irradiated The intensity distribution in the spectrum was recorded with a microphotometer in each of twelve sets of results for (*i*), (*ii*) and (*iii*) The spectral intensity was found to diminish by irradiation outside its wavelength limits. This is attributed to a decrease in the population of excited particles in the ionized and pre-ionized states

Arising out of earlier work, (Joshi, 1943; Joshi and Deo, 1942) was the question, now examined for the first time in this line of work, whether the observed suppression on irradiation of the discharge current i, constituting Joshi effect, is associated with a change in the corresponding spectrum.

The experimental arrangement was similar to that used previously (Joshi, 1943): It consisted essentially of a Siemen's type ozonizer enclosed in an opaque box and fitted with a shutter; and was excited by a 50 cycle transformer discharge. It was found that the intensity of the glow under discharge was too low for a spectrographic record even with an exposure of about 300 hours near the threshold potential V_m, where the relative Joshi-effect $\%\ \Delta i$ is maximum (Deo, 1948). A large increase in the applied potential is not an advantage, since while it increases the glow intensity, the corresponding $\%\ \Delta i$ is reduced greatly. This is shown by one typical series of data in Table I. From the results of series of trial experiments a potential of 11.3 KV of 50 cycle frequency was found to be optimum. With minimum loss of the glow intensity, it produced about 70 % of Joshi-effect, when the tube was exposed to light from a 180 volt, 200 watt incandescent bulb and with a bulb filter (4750-4000 Å) between it and the ozonizer. Hilger's constant deviation medium spectrograph was used. The linear dispersion of the instrument was 15 Å/mm at 410 mμ and 60 Å/mm at 590 mμ. The 'end on' position of the discharge tube was adopted which provides about 50 cm depth of the glowing column under discharge. The spectrum was photographed on the same plate with identical conditions

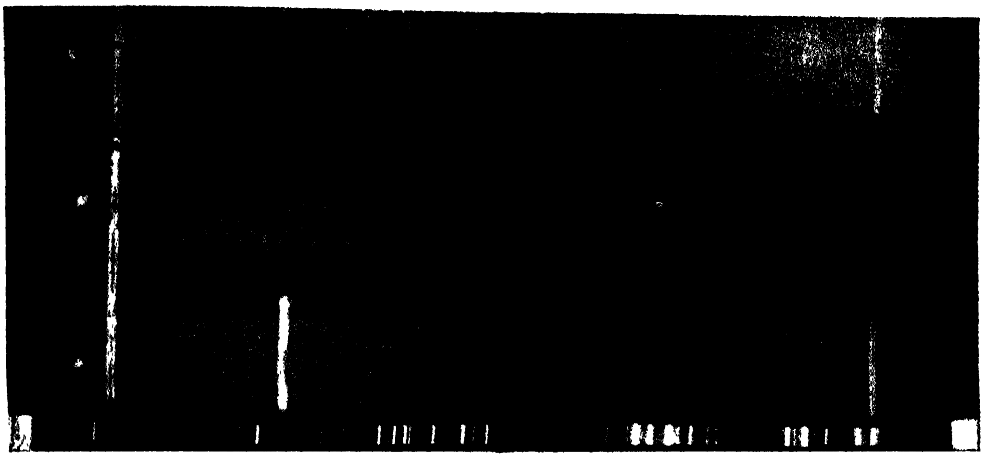

Fig 1.

Comparative emission spectra of chlorine under Joshi effect.

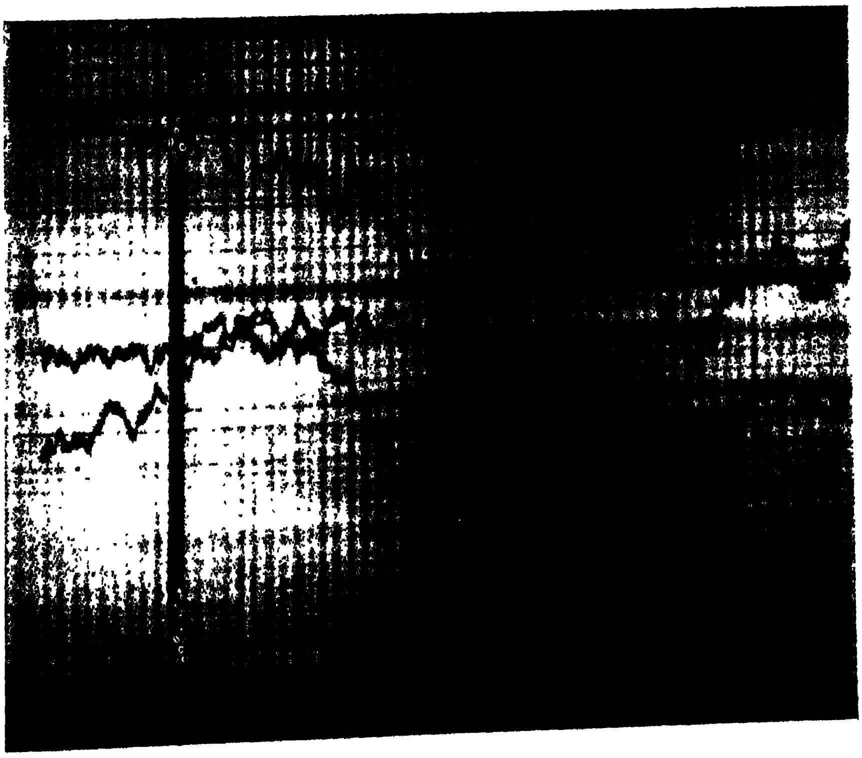

Fig 2

Microphorometer records

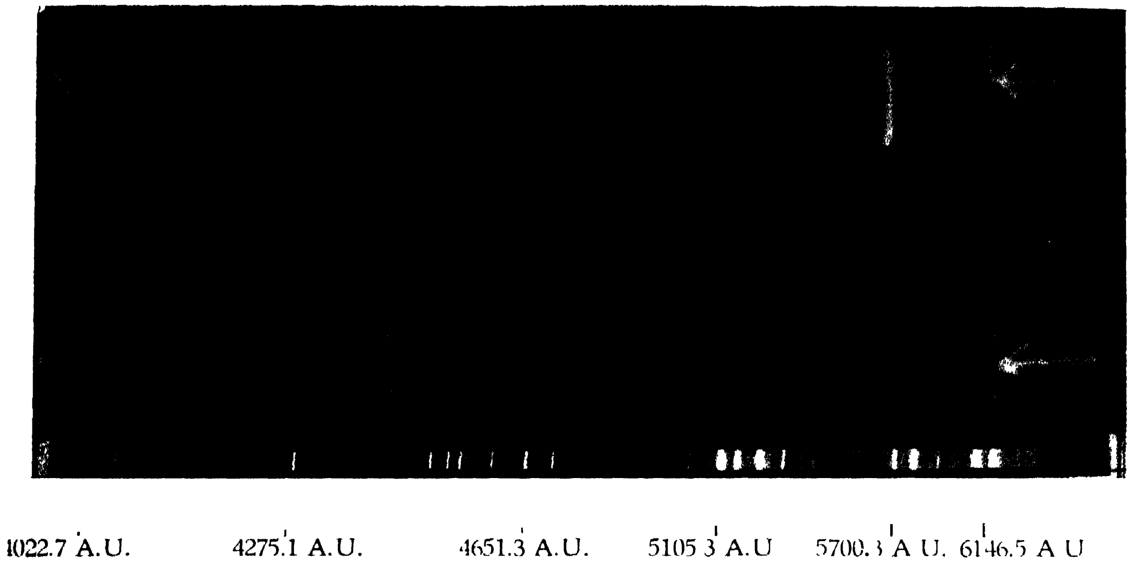

Fig. 3.

Comparative emission spectra of chlorine under Joshi effect.

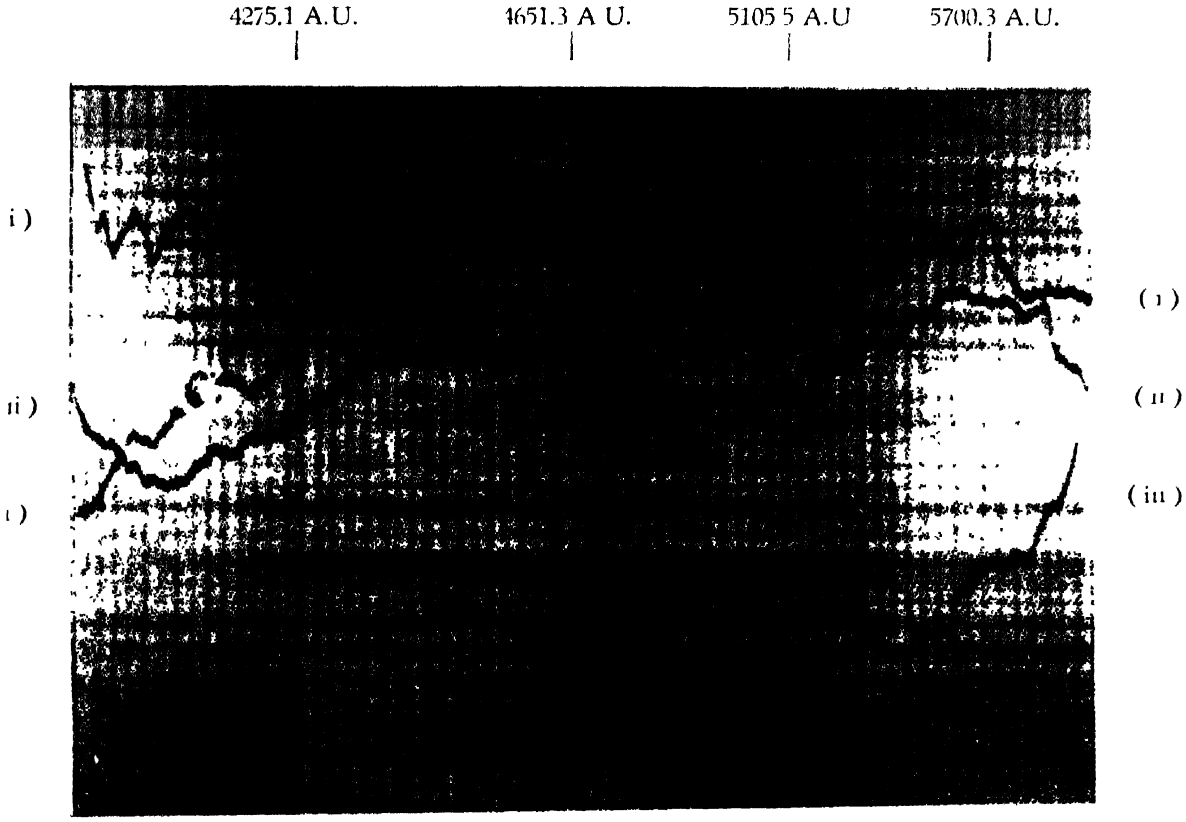

Fig 4.

Microphotometer record.

of exposure as follows: (*i*) the tube was excited at 11.3 KV, but screened from external light; (*ii*) the tube excited as in (*i*) was exposed transversely to the above filtered light and (*iii*) the unexcited tube was exposed only to radiation as in (*ii*). The distribution of intensity in the spectrum corresponding to (*i*), (*ii*) and (*iii*) were recorded with a Mohlar microphotometer. With the available glow intensity and slit width of 1 mm, an exposure of 120 hours was found necessary to obtain a reasonable impression of

TABLE I

kV	i_{dark}	i_{light}	Net Joshi effect i	Relative Joshi effect % i
6.94	15	2	13	86.0
7.21	24	4	20	83.0
7.48	34	6	28	82.3
7.74	40	9	32	80.0
8.01	48	10	38	79.1
8.28	53	12	41	77.3
8.54	60	14	46	76.6

the chlorine spectrum on fast Kodak superpanchromatic TRI-X cut films. Very considerable difficulties were experienced in the maintenance of identical operative conditions during each set of observations of (*i*), (*ii*) and (*iii*) requiring 360 hours and necessitated the exclusion of non-winter months. Two sets of spectra and the microphotometric curves shown in Plates XIX A and B are typical of a series of 12 sets of observations made during about two years.

It is seen from curves (*i*) and (*ii*) corresponding to the discharge tube being in dark and exposed to light respectively, that within the region of irradiation represented by (*iii*) the intensity distribution in (*ii*) is greater than that in (*i*) as is to be expected. It is remarkable, however, that the intensity curve (*ii*) for the irradiated discharge tube lies sensibly below the curve (*i*) characteristic of the system in dark, *but outside the spectral limits of irradiation*. This latter feature brings out the Joshi effect spectrographically.

The constituents of a gas under electrical discharge are excited to different quantum states and are in a dynamic equilibrium characterised by the activation and de-activation processes. This gives rise to the production of the distinctive band or/and line spectra. The intensity of any spectral line depends *inter alia* upon the population of the particles in the corresponding quantum states, the latter being determined by the excitation and de-excitation probabilities under the conditions of the discharge. A change in the intensity distribution under constant conditions of discharge would, therefore, suggest a change in the number of particles in the corresponding excited states. The above results indicate, therefore, that not only the ionization but also the pre-ionization states are affected.

It is known that the energy E gained by an electron in traversing a free path λ under an applied field X is given by $E=Xe\lambda$, and that during an impact a part or whole of this energy may be imparted to the gas molecule. According to Joshi, the observed decrease by light in discharge current is due to the negative space charge formed by the capture by gas (particles, chiefly atoms) of electrons, emitted under light from the electrode layer (formed in part from an absorption of ions and exeited molecules). This space charge would reduce the effective field across the gas phase and therefore, cause a decrease in the number of excited molecules and the intentity distribution of the spectrum as observed.

ACKNOWLEDGMENTS

Grateful thanks of the author are due to Prof. P. N. Sharma, D. Sc., Head of Physics Department, University of Lucknow, for encouragement, and to Prof. S. S. Joshi, D. Sc., F. N. I., Principal, College of Science, Benares, for his kind interest.

DEPARTMENT OF PHYSICS,
UNIVERSITY OF LUCKNOW

REFERENCES

Joshi, 1943, *Proc. Ind. Sci. Cong*, Presidential Address Chem Sec.
Joshi and Deo, 1942, *ibid*, Physics Sec.
Deo, 1948, *Phil. Mag.*, **39**, 978.